GRAVITY SURVEY OF THE EPICENTRAL AREA OF THE MAIN SEQUENCE OF 1982 MIRAMICHI EARTHQUAKES

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GRAVITY SURVEY OF THE EPICENTRAL AREA

OF THE MAIN SEQUENCE OF

1982 MIRAMICHI EARTHQUAKES

by

K.B.S. Burke

and

J.J. Chandra

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TABLE OF CONTENTS

	Page
List of Figures	iii
List of Tables	iv
Introduction	1
Geological Setting	3
Previous Geophysical Work	8
Gravity Survey Procedure	12
Interpretation	15
Conclusions	22
Acknowledgements	24
References	25

LIST OF FIGURES

			Page
Figure	1	Location map of gravity survey	2
	2	Geology of the North Pole Stream Granite and surrounding area	5
	3	Geology of the Miramichi Epicentral Region ..... (in pocket)	
	4	Bouguer gravity map of the North Pole Stream Granite and surrounding area	9
	5	Bouguer gravity anomaly map of the Miramichi Epicentral Region ..... (in pocket)	
	6	Gravity model of Profile AA	19
	7	Gravity model of Profile BB	21
	8	Gravity model of Profile CC	23

LIST OF TABLES

		Page
Table 1.	Main rock units in the Miramichi Earthquake area	6
2.	Density measurements for the Miramichi Earthquake area	14

INTRODUCTION

On January 9th, 1982, at 8:53 a.m. A.S.T., an earthquake of magnitude m_b =5.7 occurred in the Miramichi region of New Brunswick, approximately 120 km north of Fredericton and 80 km west of Newcastle. It was followed by several large aftershocks, including one of magnitude m_b=5.1 at 12:36 p.m. A.S.T. on January 9th and one of magnitude m_b=5.4 at 5:41 p.m. A.S.T. on January 11th. An initial analysis of aftershock activity showed that most of the epicenters were concentrated in an area of 6 km x 4 km, centred at 46°59'N and 66°36'W (Wetmiller, 1982), whilst the epicenter of the main shock was determined to be at 47°00'N (± 2.4') and 66°36'W (± 4.2') using the teleseismic recordings of the Canadian and U.S. networks (Drysdale, et al. 1982a).

Aftershocks from this general epicentral area continued to be recorded in the succeeding months of 1982; one on March 31st at 5:02 p.m. A.S.T. having a magnitude m_b=5.0 (Drysdale, et al. 1982b). What appears to have been a separate earthquake of magnitude m_N=4.6 occurred at 6:43 p.m. A.S.T. on June 16th, with an epicenter calculated to be at 47°00.6'N (± 0.6') and 66°57'W (± 0.6'), about 25 km to the west of the main sequence of earthquakes, at Trousers Lake (Drysdale, et al. 1982c).

An area of 15 km x 12 km, including the epicentral area of the main sequence of earthquakes, but excluding the epicentral area of the June 16th earthquake, has been the subject of the detailed gravity survey discussed in this report (Figure 1).

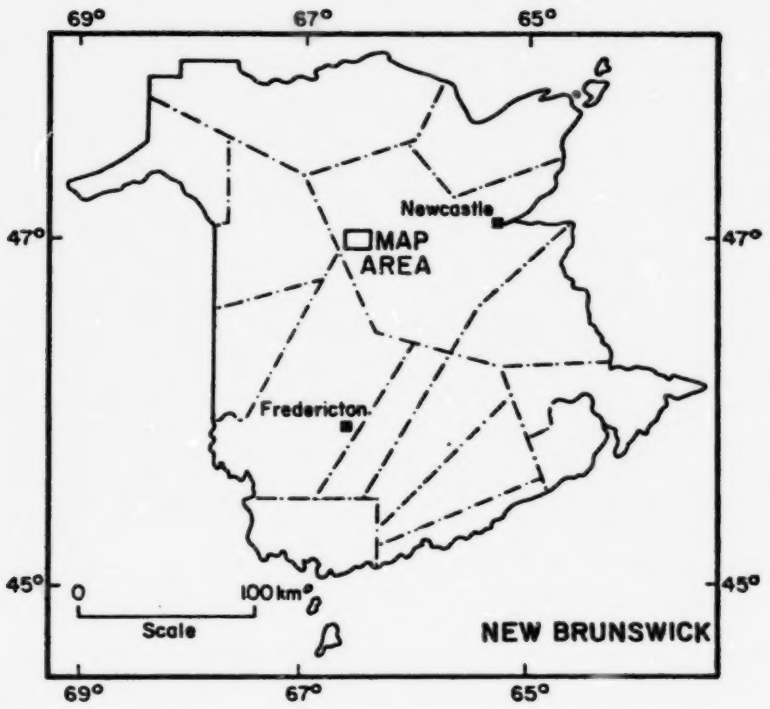

Figure 1. Location map of gravity survey.

GEOLOGICAL SETTING

The epicentral region of the Miramichi earthquakes lies in the central part of a northeasterly trending block of igneous and metamorphic rocks called the Miramichi Massif (Fyffe, et al. 1981). In the Massif, the oldest rocks exposed are Cambrian-Ordovician quartz wackes, quartzites and slates, which are overlain by predominantly felsic volcanic rocks, followed by a sequence of mafic volcanic rocks and greywackes, and locally intruded by granitoids, all of Ordovician age (Fyffe, et al. 1981).

A southeasterly dipping subduction zone, underneath a continental margin represented by the Miramichi Massif, has been proposed to explain the volcanism and igneous activity in Ordovician times (Pajari, et al. 1977). The whole of the Ordovician sequence was deformed and metamorphosed during the Taconic Orogeny. This latter orogeny was followed in Devonian times, by the Acadian Orogeny, during the late stages of and after which the Massif was intruded by a large volume of magma, mainly of granitic composition. The level of exposure of the plutons that form much of the central part of the Massif are the result of differential uplift and subsequent erosion of the Devonian intrusions (Fyffe, et al. 1981).

Post-Acadian faulting has occurred mostly on east to northeasterly trending dextral faults. One major fault, the Catamaran Fault, that cuts the Massif almost in two, displaces a granite

pluton that has been dated as 351±8 Ma (Crouse, 1981; Fyffe, 1982a). About 10 km of right lateral strike slip movement has been mapped. However, parts of the trace of the same fault are covered by unfaulted Late Carboniferous rocks, suggesting that no significant post-Carboniferous movement has affected this fracture (Rast, et al. 1979).

The immediate epicentral area of the main sequence of Miramichi earthquakes, when plotted on the 1:250,000 scale regional geological maps of Davies (1979) and Fyffe (1982b) (Figure 2), is shown to be underlain by rocks of the North Pole Stream Granite (Crouse, 1979), a granitoid intrusion of Middle Devonian age (378±7 Ma, Fyffe, 1982c), which covers an area of approximately 800 km^2. The country rocks are composed mostly of Ordovician metamorphosed sedimentary and igneous rocks and the Devonian Redstone Mountain Granite (Crouse, 1978; Fyffe and Cormier, 1979). Ordovician metasediments cover the northwestern corner of the epicentral area. The epicentral area is about 22 km north of the trace of the Catamaran Fault.

As part of the field investigations after the earthquakes occurred, Fyffe (1982c) remapped the immediate vicinity of the main sequence of earthquakes over an area of approximately 15 km by 12 km. The geology of the Miramichi Epicentral Region after Fyffe (1982c) and Crouse (1979) is shown in Figure 3 (in pocket) and the main rock types are described briefly in Table 1.

Subporphyritic biotite granite (Unit Df_2) is the predominant Devonian plutonic rock unit mapped in the area, with the older

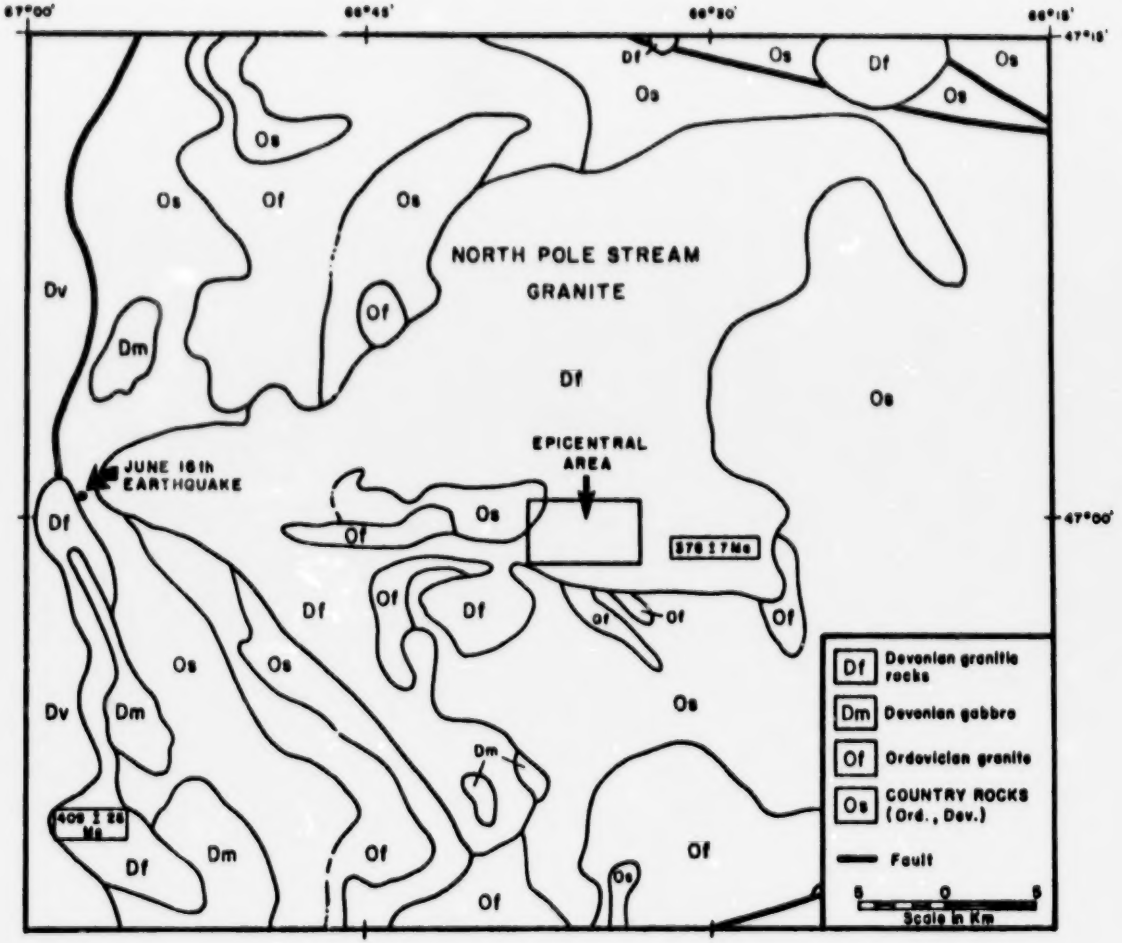

Figure 2. Geology of the North Pole Stream Granite and surrounding area based on Crouse (1978), Fyffe and Cormier (1979) and Fyffe (1982a).

TABLE I

MAIN ROCK UNITS IN MIRAMICHI EARTHQUAKE AREA

Rock Unit	Description
DEVONIAN	
$D\mathcal{G}_3$	Medium- to coarse-grained leucocratic biotite granite
$D\mathcal{G}_2$	Medium-grained equigranular to subporphyritic biotite granite
$D\mathcal{G}_1$	Fine-grained quartz-feldspar porphyry
Dm	Medium-grained diorite
ORDOVICIAN OR OLDER	
$\mathcal{O}\mathcal{G}$	Foliated granite
$\mathcal{O}p$	Foliated quartz-feldspar porphyry interlayered with amphibolite
$\mathcal{O}a$	Quartzite and phyllite

diorite (Unit Dm) being exposed in enclaves varying in size from a few tens of square metres to over 3 square kilometres. The other granitic phases consisting of an older fine-grained porphyritic phase (Unit Df_2) and a younger medium- to coarse-grained, equigranular leucocratic phase (Unit Df_3) form a small part of the pluton. The plutonic rocks are generally massive but transected by numerous joints, spaced from 5 cm to 2 m apart. The most prominent joint set is a steeply dipping to vertical, orthogonal one, with average trends of 30° (NNE) and 120° (ESE). A less prominent orthogonal set of steeply dipping joints has average trends of 0° (N) and 90° (E) (Fyffe, 1982c). It is in this latter joint system that the only evidence of possible recent movement associated with the earthquakes has been found, this being a north-trending crack about 5.0 metres long and showing about 2 cm of thrust movement (west side up). No signs of recent movement were found along the two northwesterly trending shear zones that cross the area.

The metamorphosed country rocks to the south of the pluton consist mainly of an interbedded sequence of grey quartzites and phyllites (Unit Os), but also contain deformed foliated granite (Unit Of) at two locations. A roof pendant of the Os unit overlies the plutonic rocks in the northwestern part of the area. A sequence of interlayered foliated quartz-feldspar porphyry and minor units of amphibolite, the Op unit, is present along the eastern contact of the Devonian intrusion (Fyffe, 1982c).

A bouldery ablation till, varying from 0.5 m to 1.5 m in thickness, forms the overburden in the area. The region is heavily wooded and rock exposures are confined mostly to river and stream valleys and road cuts. Geophysical investigations can therefore make a useful contribution to the interpretation of the surface geology where exposure is poor and as well contribute to the better understanding of the third dimension.

PREVIOUS GEOPHYSICAL WORK

Gravity stations at 5 to 7 km intervals were observed in central New Brunswick as part of a regional survey by the Gravity Division of the Earth Physics Branch in 1976 (E.M.R. Earth Physics Branch Open File Report 77-4). The Bouguer anomaly values from this previous survey have been plotted and contoured for the region surrounding the main Miramichi earthquake sequence and the June 16th earthquake, the contour map being shown in Figure 4.

A comparison of the gravity map with the geology map shown in Figure 2 demonstrates that there is a good correspondence between the position of the North Pole Stream Granite and a large gravity low, if allowance is made for the extension of low density plutonic rocks at depth to the southeast. The epicentral area of the main sequence of earthquakes coincides with the central axis of the gravity low and simple minimum thickness estimates, based on the slab model technique of Kane and Bromery

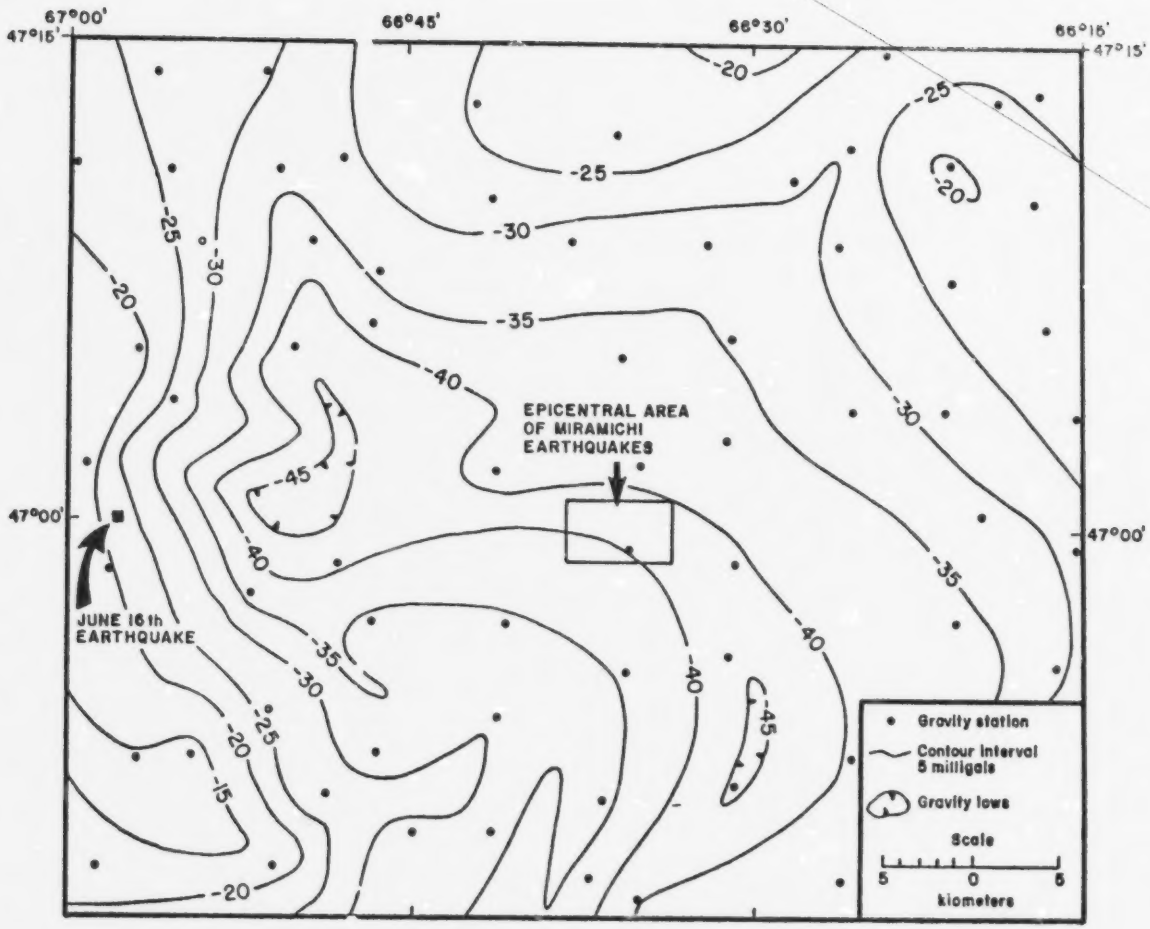

Figure 4. Bouguer gravity map of the North Pole Stream Granite and surrounding area based on E.M.R. Open File Report No. 77-4.

(1968), yield thicknesses of 4 to 12 km for a range of density contrasts between -150 kg/m^3 and -50 kg/m^3. Density measurements for rocks collected from the epicentral area (see next section) indicate that a density contrast of -100 kg/m^3 is probably the most representative value and therefore 8 km (± 2 km) has been accepted as the minimum thickness of the lower density plutonic rocks.

The epicenter of the June 16th earthquake coincides with a steep gravity gradient that has an approximate northwest to southeast trend. The steep gradient may be explained, in the south, by a positive density contrast between a Devonian gabbro, that is exposed to the west of the North Pole Stream Granite, and the lower density plutonic and country rocks. The steep gradient does in fact develop into a closed high over the most extensive exposure of the gabbro in the southwestern corner of the map-area. A nosing of the contours eastward towards two megaxenoliths of the gabbro, within the granite in the south-central part of the region, suggests that this rock unit is more extensive at depth than indicated by its surface exposure. In the north, the gravity gradient coincides with a major northerly striking fault separating Devonian volcanics to the west from Ordovician metasediments to the east (Crouse, 1977). The association of the June 16th earthquake with this fault is strengthened by the probable eastward dip of the fault (Fyffe, 1982b). The "dog leg" pattern of the gravity contours, about 3 km to the northwest of the June 16th epicenter, probably reflects

the contact between the North Pole Stream Granite and the denser rock units to the north. The correlation between earthquake epicenters and gravity gradients at the boundaries of intrusions in western Quebec has previously been noted by Forsyth (1981), who also states that structural weaknesses, in addition to the mass inbalance at the intrusion edge, are necessary if there is to be rock failure.

Two aeromagnetic surveys have been flown over the region. A fluxgate magnetometer survey was flown in 1950 for the Resource Geophysics and Geochemistry Division of the Geological Survey of Canada and, in 1972, a rubidium vapor magnetometer survey was flown as a joint project of Energy, Mines and Resources and the New Brunswick Department of Natural Resources, sponsored by the Canada Department of Regional Economic Expansion. A nominal flight altitude of 500 feet (152.4 m) above ground level, with an average line spacing of 0.5 mile (0.8 km), was used for the fluxgate magnetometer survey. The high sensitivity, rubidium vapor magnetometer survey was flown at 3,000 feet (914.4 m) above sea level (ground elevation in the epicentral region varies between 1,000 feet (304.8 m) and 1,500 feet (457.2 m) above sea level) with an average flight line spacing of 1,000 feet (304.8 m).

A preliminary analysis of the aeromagnetic maps from both surveys shows the epicentral area of the main sequence of earthquakes to be generally characterized by the smaller anomalies and gentler gradients normally associated with

granitoid rocks. Superimposed on this relatively flat background are a few isolated more intense magnetic highs associated with the diorite and some parts of the phyllites. In contrast, the June 16th earthquake epicenter is in an area of complex magnetic gradients and large magnetic highs associated with the gabbro unit. A fuller analysis of the magnetic data will be made in a later Open File Report (Burke and Chandra, in preparation).

GRAVITY SURVEY PROCEDURE

The detailed gravity survey of the epicentral area was commenced in March, 1982, in order to take advantage of measurements on the ice surfaces of the still frozen lakes and the frozen swampy ground. Four-wheel drive vehicles and snowmobiles were used to obtain access to the survey area.

Gravity readings were taken with a Scintrex CG2 gravity meter at places whose approximate positions could be identified on 1:12,500 air photographs of the area. Altimeter traverses and also stereo-analysis of the air photographs provided elevation information for the gravity stations. Later, during the summer months, the elevations of the lake surfaces were determined by using a Hewlett Packard Electronic Distance Meter (EDM) and a comparison of these elevations with the results of the altimeter and stereo-analysis show that the precision varied between 1 m and 3 m for elevations of individual gravity stations in the lake areas.

In the summer survey work, the CG2 gravity meter was again used to obtain the gravity readings along the various roads and trails in the area at station intervals of roughly 0.5 km. The EDM, supplemented by conventional levelling traverses, was used to provide station elevations relative to a central Bench Mark, whose elevation had previously been established by the Maritime Land Registry Service. Rock samples were collected from 31 outcrops and density values have been obtained by hydrostatic weighing for all the main rock types exposed in the area (Table 2).

Although the road and trail access gave a reasonable coverage over about three-quarters of the survey area, there was a significant lack of gravity stations in the more inaccessible northwestern quadrant. During the fall of 1982, 7 lines were cut and gravity stations established at 0.5 km intervals in the northwestern quadrant, in a survey financed by Weston Geophysical Corporation of Westboro, Massachusetts. This set of data may be made public at some future date.

The elevation precision of the summer stations varied between 0.1 and 1.0 m, based on repeated determinations at about 5% of the stations. All of the gravity data have been reduced to Bouguer anomaly values using a reduction density of 2,670 kg/m^3 and a datum surface of mean sea level. No terrain corrections have been applied. A Bouguer anomaly contour map of the area is shown in Figure 5 (in pocket).

TABLE 2

DENSITY MEASUREMENTS FOR THE MIRAMICHI EARTHQUAKE AREA

Rock Type	No. of Samples	Range of Density Values	Standard Deviation	Mean Density Value and Standard Error
		kg/m^3	kg/m^3	kg/m^3
Phyllite *Os*	11	2789-2854	22	2839±5
Quartzite *Os*	37	2613-2775	31	2713±5
Quartz-feldspar porphyry *Op*	15	2652-2700	14	2678±4
Foliated granite *Of*	16	2633-2669	9	2645±2
Diorite *Dm*	32	2741-2822	27	2777±5
Quartz-feldspar porphyry Df_1	25	2590-2643	16	2624±3
Porphyritic biotite granite Df_2	77	2593-2693	26	2657±3
Leucocratic granite Df_3	7	2610-2622	5	2613±2
Red microgranite and aplite *Kg*	21	2552-2615	19	2591±4

INTERPRETATION

Before considering the interpretation of the Bouguer anomaly map, it is instructive to review the density values given in Table 2.

There is a wide range of density values listed for the metamorphic country rocks (2663-2854 kg/m^3), as is to be expected for such a varied group of rocks. The phyllite and quartzite rock types of the metasedimentary sequence (Unit Os) have mean densities of 2839 kg/m^3 and 2713 kg/m^3 respectively. Where mapped in the area, these are interbedded and therefore, assuming similar thicknesses of both rock types, a mean value of 2780 kg/m^3 has been accepted as representative for the metasedimentary sequence, dealing with them as a single body. The quartz-feldspar porphyry (Unit Op) and the deformed foliated granite (Unit Of) have mean densities of 2678 kg/m^3 and 2645 kg/m^3 respectively, about 100 kg/m^3 lower than the metasediments, but similar to the mean density (2657 kg/m^3) of the main granitoid unit (Unit Df_2). Two samples of amphibolite collected from Unit Op have a density value of 2970 kg/m^3 (not shown in Table 2), but as amphibolite is reported to occur only infrequently, and then in thin layers of about 1.0 m in thickness (Fyffe, 1982c), it is unlikely that the presence of amphibolite will have a significant influence on the contours of the Bouguer anomaly map, considering the station interval of 0.5 km. In the interpretation of the gravity map, the metasediments (Unit Os)

have been considered to have a positive density contrast of 100 kg/m^3 with respect to Unit Df_2 and Units Of and Op to have the same density as Unit Df_2.

The diorite (Unit Dm) has the highest mean density (2,777 kg/m^3) of the plutonic rocks, compared to the mean densities of 2624, 2657 and 2613 kg/m^3 respectively for the granitic rocks (Units Df_1, Df_2 and Df_3). The red microgranite and aplite units have a still lower mean density of 2,591 kg/m^3, perhaps because of the scarcity of higher density mafic minerals, and also all of the available samples were partially weathered. A positive density contrast of 100 kg/m^3 between Units Dm and Df_2 has been accepted for modelling purposes in the following interpretation.

On the Bouguer anomaly contour map (Figure 5), the main epicentral area (rectangle on map) is characterized by a broad gravity low, flanked, to the northwest and southeast, by closed gravity highs. This contour pattern reflects the lower densities of the granitic units compared to the diorite (Unit Dm). The diorite appears to be more extensive than suggested by the few exposures within the pluton if we compare their dimensions to the much greater areal size of the closed gravity highs. There is a corresponding increase in gravity values to the north and east of the main epicentral area supporting the idea that Unit Dm is more extensive than indicated by the mapped surface exposures (Figure 3), particularly at depth.

There is little expression of the contact between plutonic and country rocks in the gravity contours in the southern part of the gravity map-area (Figure 5). A gravity low, probably

controlled by thickening of Unit Df_2, cuts across the contact in the southeast. A more localized gravity low in the Holmes Lake area is interpreted as being caused by a thickening and extension of the low density foliated granite (Unit Of), to the west of its mapped exposure. Between these two gravity lows, there is a positive gradient of about 1.5 milligals per kilometre to the southwest indicating a gradual thickening of metasediments in this direction.

In the southwestern corner of the survey area, there is a conflict between the position of a gravity high, centred in the Tuadook Lake area, and the geological interpretation shown in Figure 3. The geology map shows a gap in the metasediments (Unit Os), that is mostly filled by the lower density Unit Df_2, and thus one would expect a gravity low rather than a gravity high in this area. However, there is one exposure of the diorite (Unit Dm) on the northern shore of Tuadook Lake and so it is again possible that this latter unit is more extensive at depth than indicated by its surface exposure.

Neither of the two shear zones shown in Figure 3 exert much influence on the contour pattern of the Bouguer anomaly map. There is some parallelism of two contours about 2 km from the northwestern end of the northernmost shear zone that may reflect a faulted contact between the diorite (Unit Dm) and the granites of Unit Df_2, but station spacing is too large to map this with any confidence.

An attempt has been made to model the geological section

under three Bouguer anomaly profiles drawn at the locations shown on the contour map in Figure 5. A 2½ D gravity effect computer program of Milsom and Worthington (1977) was modified and used for this purpose. The modified program allows up to 10 separate bodies of polygonal cross-section, and either infinite (2D), or limited strike length, to be modelled. The total calculated gravity effect of all the bodies is finally compared with the observed gravity anomaly profile. A model was accepted as a fit if the residuals between calculated and observed individual values were ± 0.30 milligals and the root mean square difference of all the residuals was less than 0.1 milligals.

The profile AA (Figure 5) over the northwestern gravity high in the main epicentral area has been modelled successfully as a 2D prism of diorite (Figure 6). The prism has a width of 2 km and extends from just below the surface to depths of 1.5 to 1.6 km in the southeast, immediately under the gravity high but thins to a slab 0.5 km in thickness to the northwest.

A similar attempt has been made to model profile BB (Figure 5) as a diorite body in the southeastern part of the epicentral area. However, it has not been possible to model this anomaly profile successfully within the constraints of the established density contrasts, because the narrow anomaly and steep gradients require a relatively thin body, which does not extend to great depth, and hence the body must have a higher density contrast with the surrounding rocks to account for the amplitude of the anomaly. Determination of the lowest value of the density

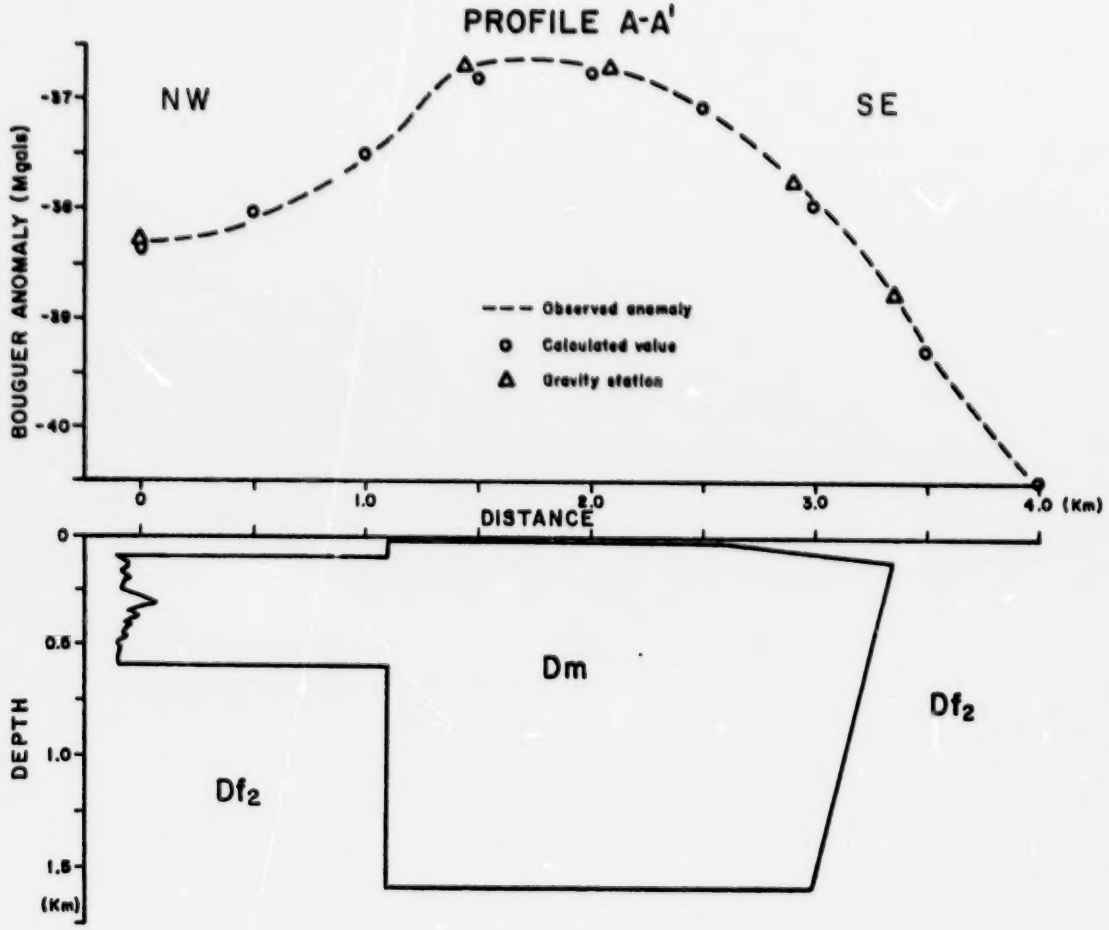

Figure 6. Gravity model of Profile AA'

contrast using the method of Parker (1974) gives a minimum density contrast of 190 kg/m^3 for adjacent stations along the profile.

A partially satisfactory fit has been found for the model shown in Figure 7 by using a density contrast of 250 kg/m^3. The model consists of two prisms with a strike length of 1.6 km, the northernmost prism being 0.45 km wide and 0.12 km thick and the southernmost prism being 0.28 wide and 0.50 thick. The residuals on the flanks of the southern anomaly exceed the residual limit of + 0.30 milligals, but because of the station interval of 0.5 km, it is quite possible that the interpolation of contour lines to represent this anomaly is not as simple as assumed in the preparation of the contour map in Figure 5. Hence, it is desirable that more gravity stations be established in this area to map the true shape of the anomaly.

The density contrast of 250 kg/m^3 needed to obtain a satisfactory fit to profile BB needs comment. The density contrast is indeed high compared to that established from the mean values of the density measurements on samples from Units Df and Dm. However, it can just be accommodated if the extremes of the density ranges of the latter two units are considered (Table 2). Another possibility is that Unit Dm underlying this anomaly contains a gabbroic phase with a higher density. Gabbros are identified as being present in the regional geological map of Fyffe (1982b) but unfortunately no outcrop has been found in the vicinity of profile BB to test this explanation.

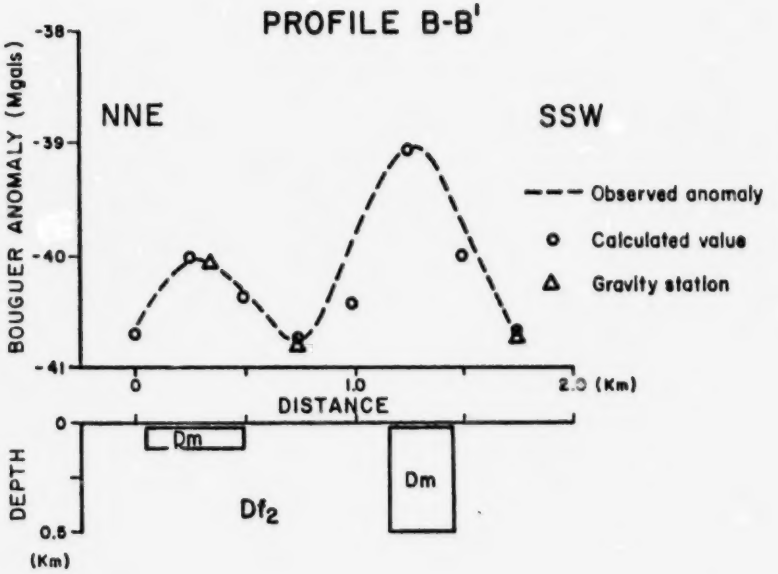

Figure 7. Gravity model of Profile BB'.

The 2D model that has been found to fit the anomaly profile CC (Figure 5) over the southern contact between plutonic rocks and metasediments is shown in Figure 8. A wedge of metasediments (Unit Os) with a gentle dip of 22° can explain most of the anomaly profile. An allowance has been made for a near surface layer of lower density foliated granite (Unit Of) between 1.3 and 3.0 km along this profile, this latter unit being exposed at the surface in this part of the area. From the results of profile CC, it is seen that the thickness of metasediments in the area of the earthquakes is unlikely to exceed 1 km.

CONCLUSIONS

The relatively small gravity anomalies and gentle gradients indicate that the main epicentral area is mostly underlain by Unit Df granitic rocks, but bounded to the northwest and southeast by small diorite bodies of Unit Dm in the upper part of the crust. Minimum thickness estimates and the fitting of a simple rectangular prism to the main gravity low associated with the North Pole Stream Granite on the regional gravity map yield a value of 8 km as the probable thickness of the overall plutonic body. Only a relatively thin cover of metasedimentary rocks (0-1.0 km) can be accommodated by the gravity values in the gravity map-area.

Because the focal depths reported for the aftershock sequence are in the range from 1-7 km (Wetmiller *et al.*, 1982)

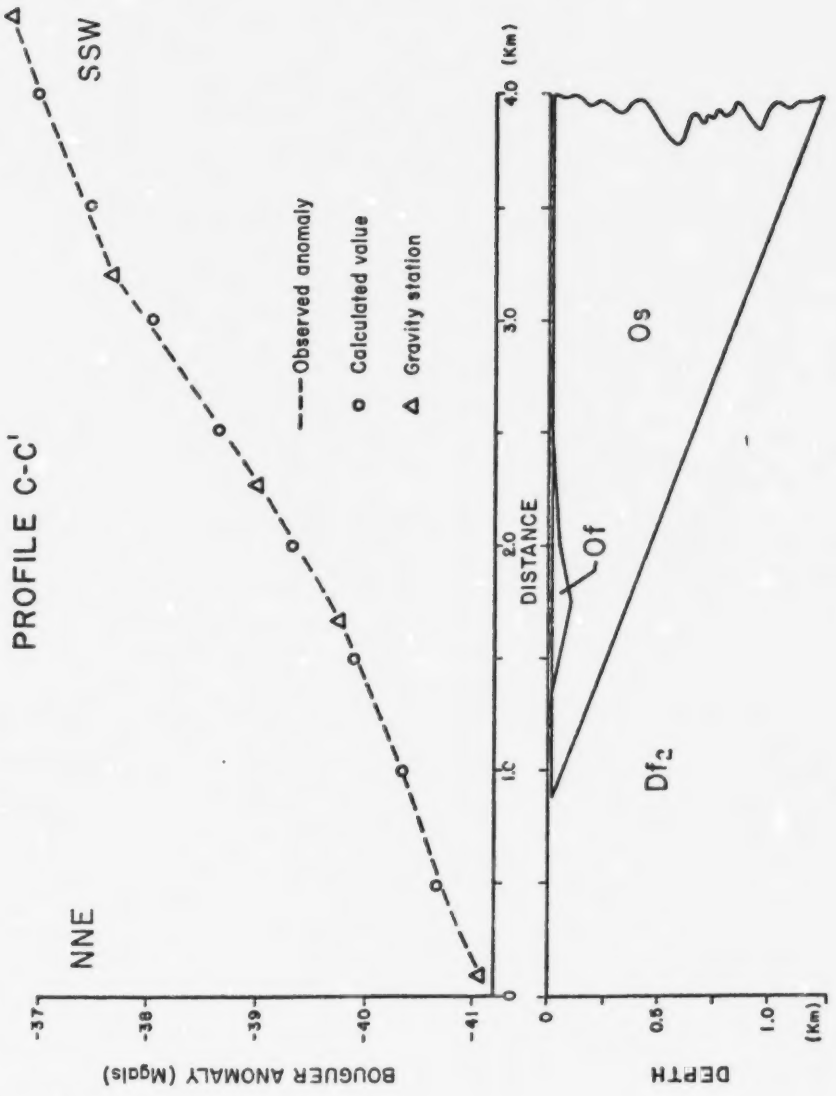

Figure 8. Gravity model of Profile CC'.

and because the plutonic rocks underlie the surface at relatively shallow depths, even to the south of the mapped pluton-country rock boundary, it is believed that the Miramichi earthquakes are confined to the rocks of the pluton. It has been noticed when splitting rock samples for density measurements that the granitic rocks shatter in a brittle fashion and break easily even under a small hydraulic load, whereas the metamorphic country rocks are tougher and some samples were even impossible to break under the maximum load of the machine. There is also evidence of cataclastic deformation of minerals in some of the collected samples of Unit Df (this was also noted by Fyffe, 1982c).

It is therefore suggested that the rocks of the pluton are weaker than the surrounding metamorphic country rocks and when exposed to a changed stress level or system, they are more likely to fail in a brittle manner. Earthquakes in this region may therefore be confined to zones of brittle failure in the pluton. The contrast in rigidity provided by the diorite bodies may also play a role. Adjustments in the rate of plate movement or stresses associated with isostatic adjustment of the crust are possible candidates for the change in stress regime.

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66°42'
66°41'
66°40'
66°39'
66°38'
66°37'
66°36'
66°35'

Df_2

Dm

85

Dm

75

Df_2

Os

Os

66°36 66°35 66°34 66°33 66°32 66°31 66°30 66°29 47°03

Long Lake

Op

Df_2

Dm

Df_1

Dm

84

75

Df_1

Df_1

75

80

70

55

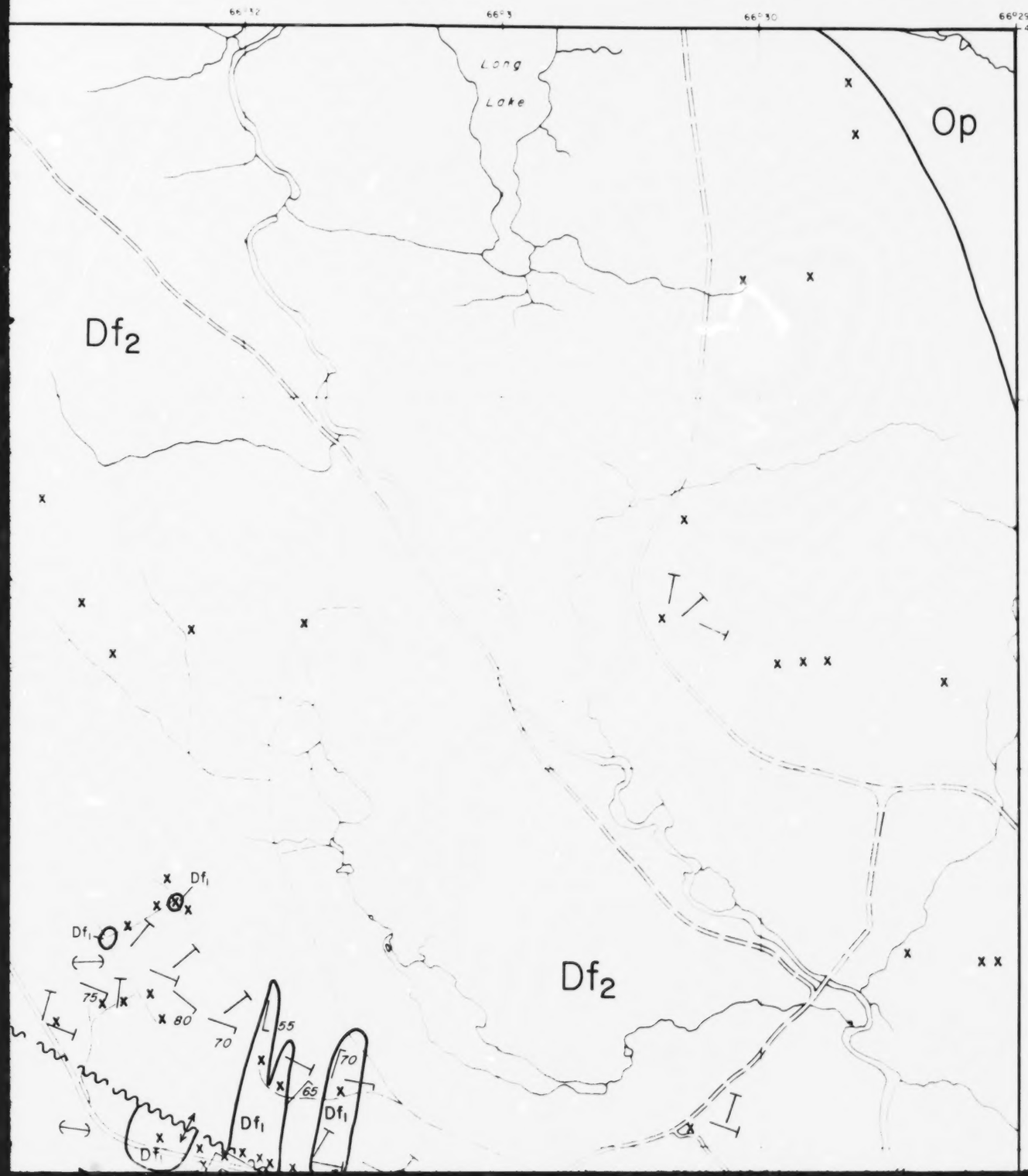
65

70

Df_1

Df_1

Df_2



PROVINCE OF NEW BRUNSWICK
DEPARTMENT OF NATURAL RESOURCES
GEOLOGICAL SURVEYS BRANCH

GEOLOGY
of the
MIRAMICHI EPICENTRAL REGION

After L.R. Fyffe, 1982, 1979, 1972; G.W. Crouse, 1979

(TO ACCOMPANY OPEN FILE REPORT NO. 83-3)

DEVONIAN

- *Dark grey, fine-grained diabase*
- *Red microgranite and light pink aplite*
- Df_3 — *Light pink to red, medium-to coarse-grained leucocratic biotite granite, white microgranite*
- Df_2 — *Light grey to light pink, medium-grained, equigranular to subporphyritic biotite granite*
- Df_1 — *Light grey, fine-grained, quartz-feldspar porphyry*
- Dm — *Dark grey, medium-grained diorite*

ORDOVICIAN OR OLDER

- Of — *Light grey to pink foliated granite*
- Op — *Grey, foliated quartz-feldspar porphyry interlayered with dark green amphibolite*
- Os — *Grey quartzite and phillite*
- x — *Rock outcrop*

66°42'
47°03'
66°41'
66°40'
66°39'
66°38
66°37
66°36
66°35
-37.85
-37.66
-37.46
-37.29
-38
-37.41
-38.9
-38.05
-38.39
-38.14
-37.74
-37.97
A
-38
-37
-39.52
-40.24
-37.28
-38.10
-36.69
-36.61
-37.27
-38.11
-37.61
-37.35

66°36 66°35 66°34 66°33 66°32 66°31 66°30

Long Lake

PRINCE'S LODGE

-37.96 -37.87 -37.99 -37.40 -37.78 -38.04 -38.25 -38.42 -38.87 -39.12 -39.26 -39.44 -39.52 -39.87

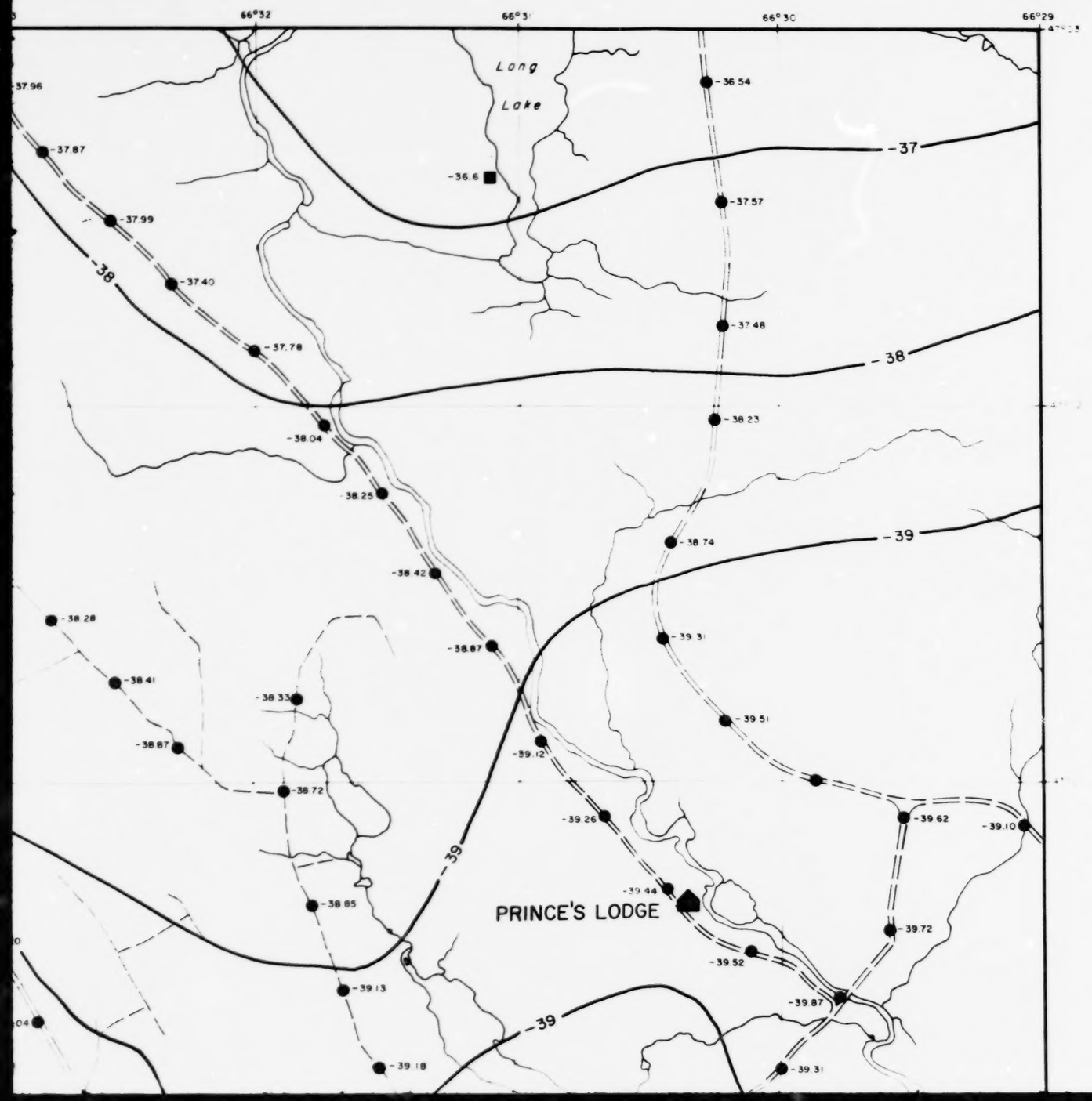
-36.54 -37.57 -37.48 -38.23 -38.74 -39.31 -39.51 -39.62 -39.10

-36.6

-37.41 -38.05 -38.39 -38.14 -37.74 -37.97 -38.32 -38.54 -39.30 -40.26 -40.20 -40.22 -40.04 -39.52 -40.24 -40.46 -38.9 -38.28 -38.41 -38.87 -38.33 -38.72 -38.85 -39.13

-36.69 -36.81 -37.28 -38.10 -37.61 -37.35

-37 -38 -39 -40



PROVINCE OF NEW BRUNSWICK
DEPARTMENT OF NATURAL RESOURCES
GEOLOGICAL SURVEYS BRANCH

BOUGUER GRAVITY ANOMALY MAP of the MIRAMICHI EPICENTRAL REGION

(Milligals)

Compiled by
J. J. CHANDRA, J. W. WALLACE and K. B. S. BURKE
1982

(TO ACCOMPANY OPEN FILE REPORT NO. 83-3)

LEGEND

Os

Os

Df_2

Df1

Dm

75

Of

Df_2

Dm

Dm

Of

Os

Df_2

80

Dm

Df_3

85

73

80

85

Dm

80

Df2

Df1

Dm

75

54

Df1

Df1

75

80

70

55

70

65

Df1

Df1

Df1

Df2

Df2

50

78

80

Df3

Dm

85

73

77

77

15

Dm

85

Df2

80

85

Dm

80

80

45

86

Dm

Dm

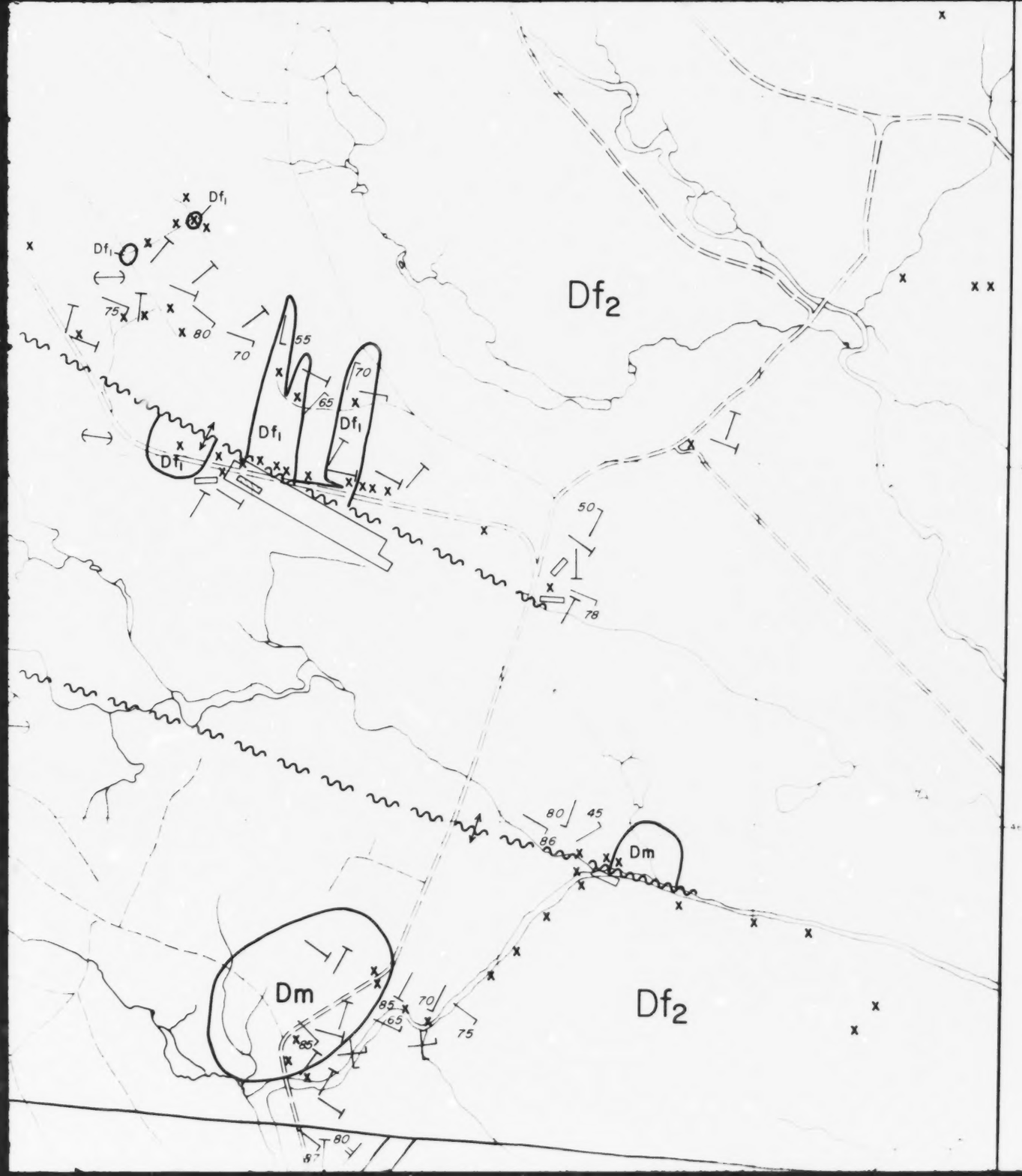
85

65

70

75

Df2



DEVONIAN

- Dark grey, fine-grained diabase
- Red microgranite and light pink aplite
- Df_3 Light pink to red, medium-to coarse-grained leucocratic biotite granite, white microgranite
- Df_2 Light grey to light pink, medium-grained, equigranular to subporphyritic biotite granite
- Df_1 Light grey, fine-grained, quartz-feldspar porphyry
- Dm Dark grey, medium-grained diorite

ORDOVICIAN OR OLDER

- Of Light grey to pink foliated granite
- Op Grey, foliated quartz-feldspar porphyry interlayered with dark green amphibolite
- Os Grey quartzite and phillite
- x Rock outcrop
- Geological boundary
- 30 Bedding (tops unknown)
- 20 Schistosity (inclined)
- Shear zone (defined, approximate, vertical, inclined)
- 85 75 Joint (horizontal, inclined, vertical)
- Quartz vein
- Glacial striae (direction of ice movement unknown)

Epicentral block

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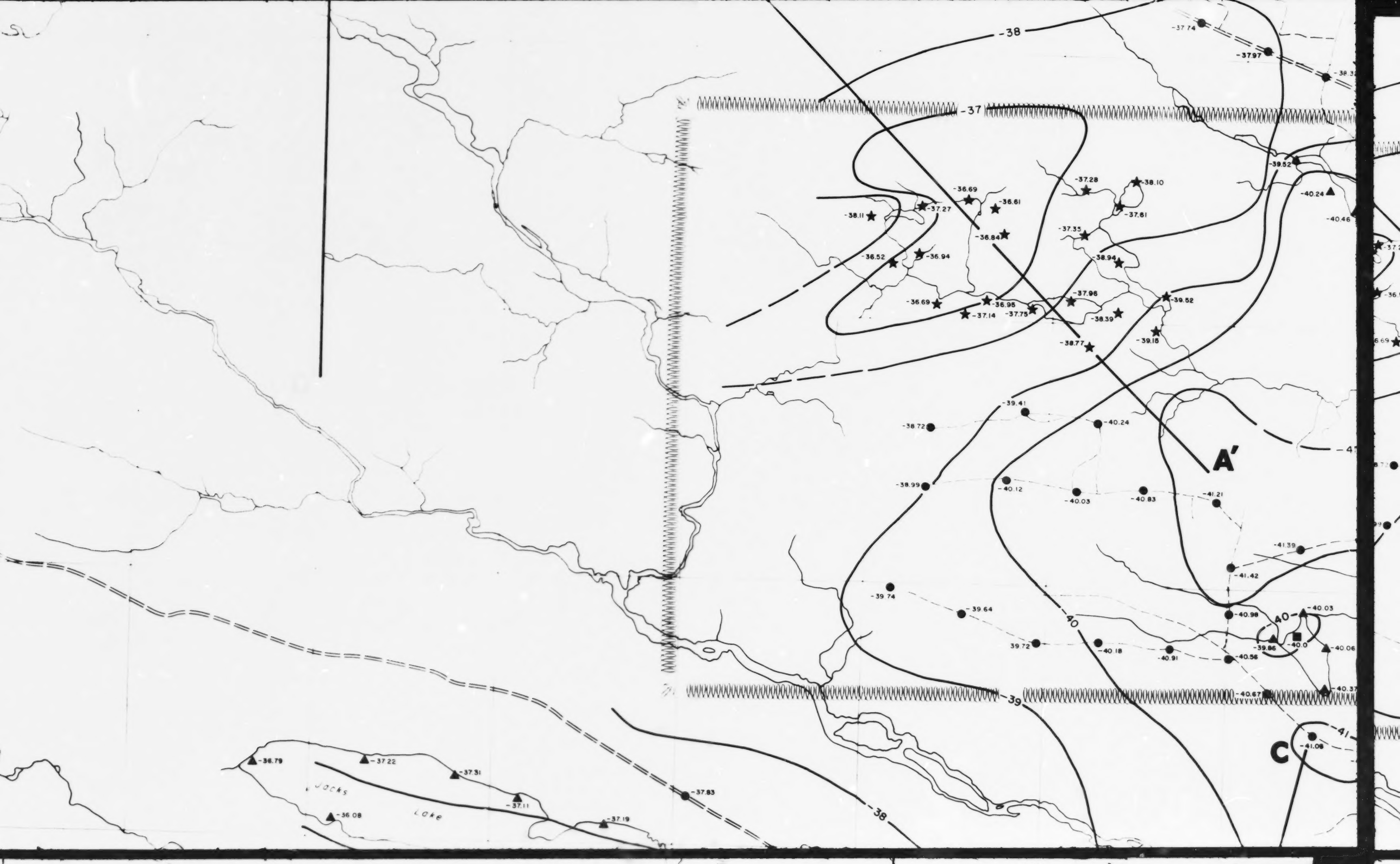

-38
-37
-39
-40
-41
A
A'
C
-37.74
-37.97
-39.52
-40.24
-40.46
-36.69
-36.61
-37.27
-38.11
-36.84
-37.28
-38.10
-37.61
-37.35
-36.52
-36.94
-38.94
-36.69
-36.95
-37.14
-37.75
-37.98
-39.52
-38.39
-39.18
-38.77
-39.41
-38.72
-40.24
-38.99
-40.12
-40.03
-40.83
-41.21
-41.39
-41.42
-39.74
-39.64
-40.98
-40.03
-39.72
-40.18
-40.91
-40.56
-39.86
-40.0
-40.06
-40.37
-41.08
-36.79
-37.22
-37.31
-37.11
-36.08
-37.19
-37.83
LOCKS
LAKE

PRINCE'S LODGE

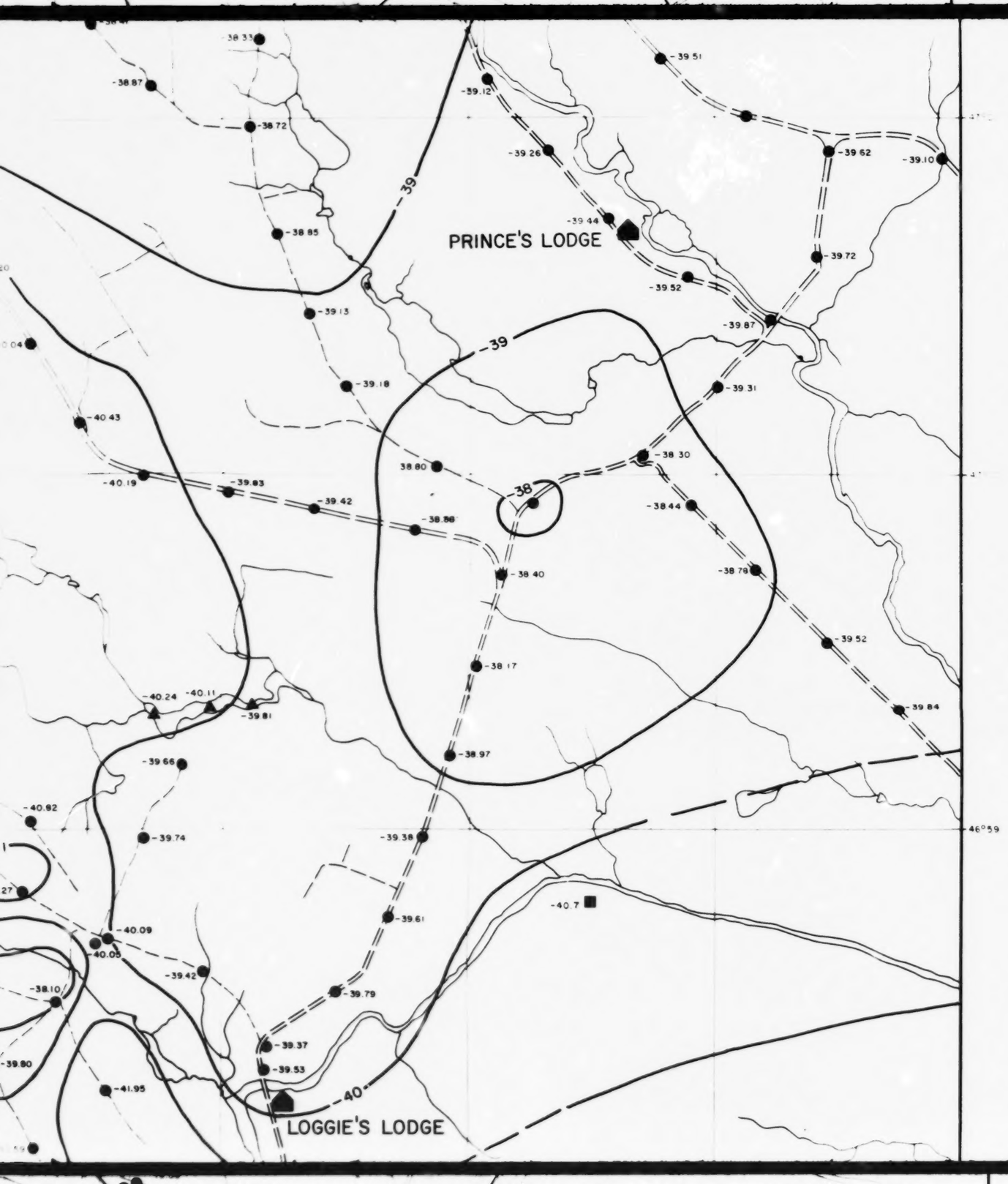
LOGGIE'S LODGE

A'

B

B'

C



J. J. CHANDRA, J. W. WALLACE and K. B. S. BURKE
1982

(TO ACCOMPANY OPEN FILE REPORT NO. 83-3)

LEGEND

Bouguer anomaly reduced to sea level
Bouguer correction computed for density of 2.67 gm/c^3

Elevation Precision:

- ● ± .10 metre
- ▲ ± 1.0 metre
- ■ ± 3.0 metre
- ★ ± 5.0 metre

A——A' Modelled gravity profiles

Epicentral block

PLATE 83-8

Of

Os

Dm

Df2

Dm

Df2

Dm

Df2

Os

Df2

Os

Os

Of

Os

Holmes

Lake

Os

Dm

80

85

Dm

80

Dm

Dm

Dm

Df_2

Os

Of

Os

Os

Os

Os

Of

Of

Airstrip

Lake

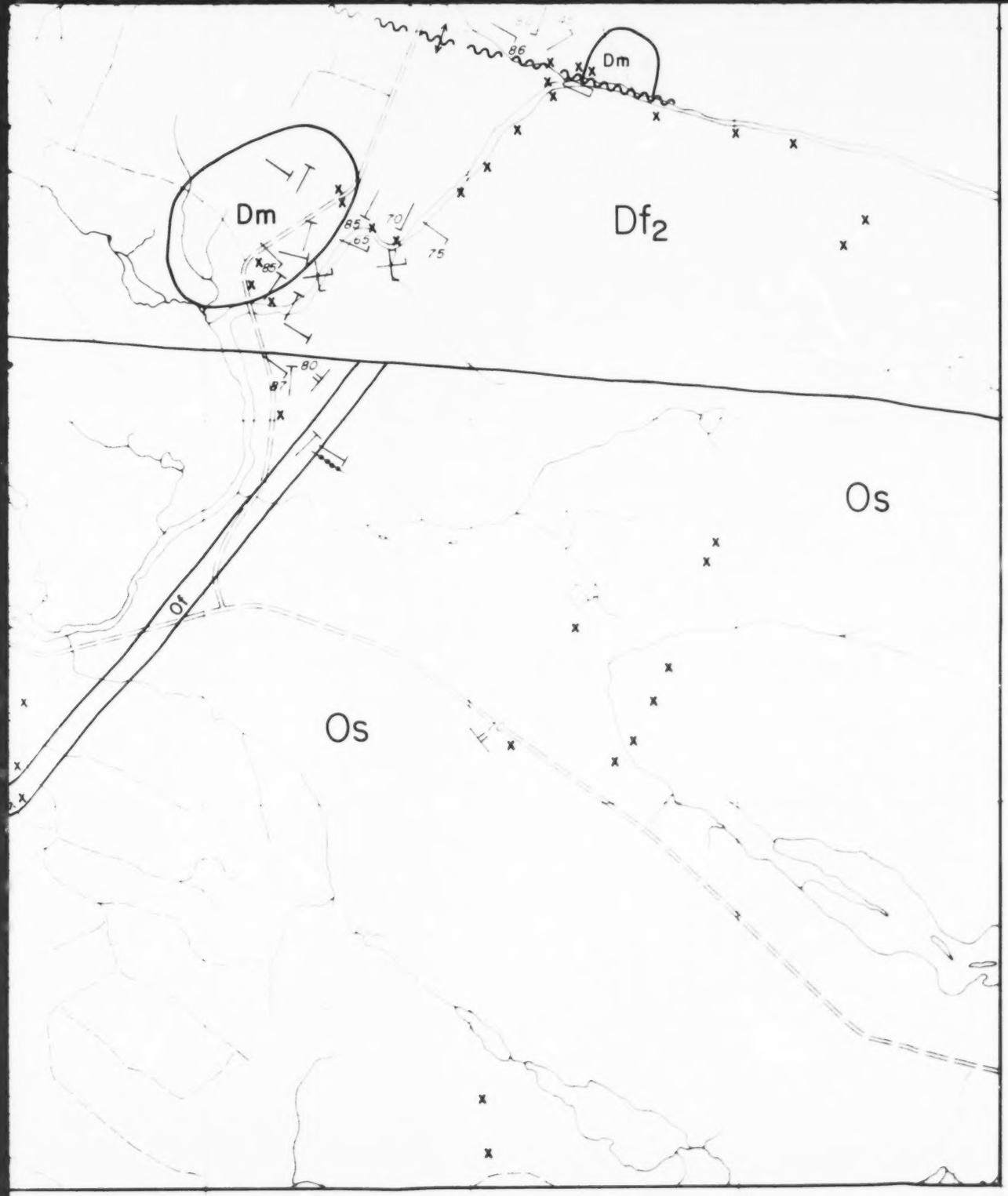


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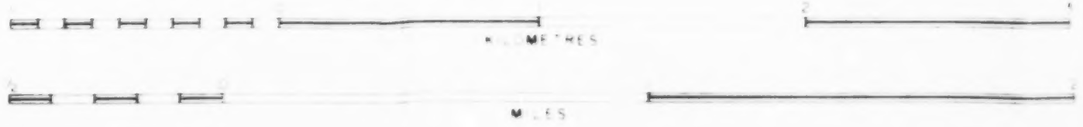
FIG. 3

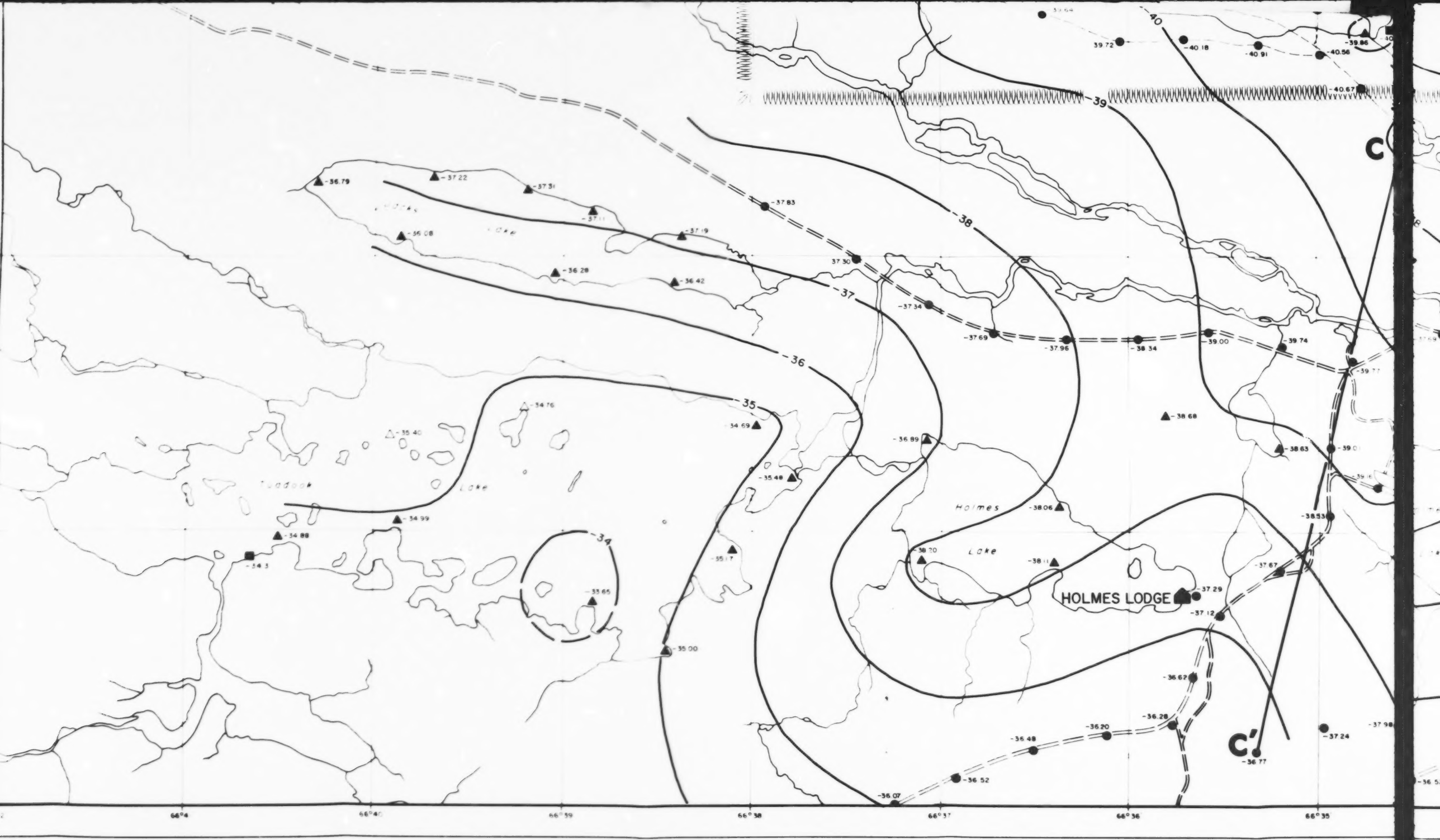
[OPEN FILE REPORT 83-3]

PLATE 83-5

LOCATION MAP

SCALE




-36.79
-37.22
-37.31
-37.11
-36.08
-37.19
-36.29
-36.42
-37.83
-38
-37.30
-37.34
-37.69
-37.96
-38.34
-39.00
-39.74
-39.77
-39
-39.72
-40.18
-40.91
-40.56
-39.86
-40.67
-40
-36
-35
-34
-34.76
-35.40
-34.69
-36.89
-35.48
-38.68
-38.63
-39.0
-38.06
-38.53
-38.70
-38.11
-37.67
-37.29
HOLMES LODGE
-37.12
-36.62
-36.28
-36.20
-36.48
-37.24
-37.98
C'
-36.77
-36.52
-36.07
-35.17
-34.99
-34.88
-34.3
-33.65
-35.00
Todzook
Lake
Holmes
Lake
C
66°41
66°40
66°39
66°38
66°37
66°36
66°35

LOGGIE'S LODGE

HOLMES LODGE

C

C'

B'

66°36

66°35

66°34

66°33

66°32

66°31

66°30

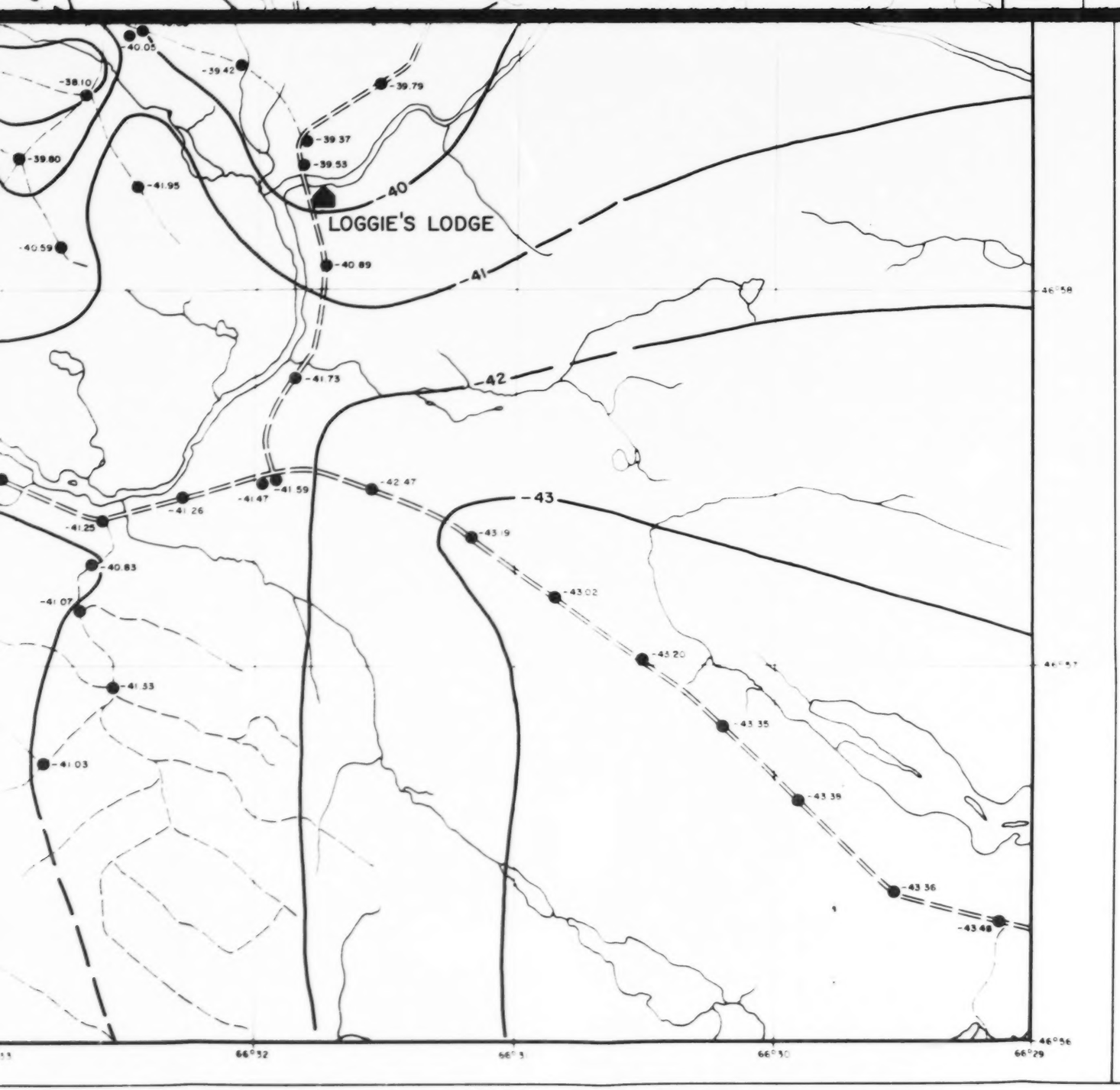


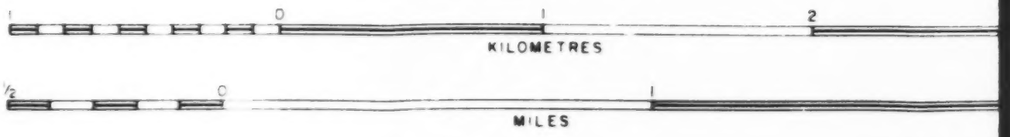
PLATE 83-8

FIG. 5

(OPEN FILE REPORT 83-3)

LOCATION MAP

Scale 1:20,000



POOR

QUALITY

ORIGINAL